9724906

943.3
-115
2
.3

97313 4

ISWS-73-CIR115
Circular 115
STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

ILLINOIS DOCUMENTS
MAY 21 1973
ILLINOIS STATE LIBRARY

Withdrawal of Water by Industry in Illinois, 1970-1971

by D. H. SCHNEPPER, J. C. NEILL, and R. L. EVANS

ILLINOIS STATE WATER SURVEY
URBANA
1973

ILLINOIS STATE LIBRARY
SPRINGFIELD

I543.3 Wc-115
Schnepper, Donald H
Withdrawl of water by industry in
Illinois, 1970-71
7326249

ILLINOIS STATE LIBRARY

CONTENTS

	Page
Abstract	1
Introduction	1
Data and analysis	3
General	4
Major industry groups	5
Specific industry groups	5
Surface water supplies	7
Major counties	8
Major streams	10
Hydrologic basins	12
Groundwater supplies	14
Major counties	14
Major industry groups	16
References	17

7326249

Printed by authority of the State of Illinois -- Ch. 127, IRS, Par 58.29
(5-73-1500)

WITHDRAWAL OF WATER BY INDUSTRY IN ILLINOIS, 1970-1971

by D. H. Schnepper, J. C. Neill, and R. L. Evans

ABSTRACT

Surface water and groundwater withdrawal rates were obtained from 3029 industrial establishments by mail canvass. An evaluation of the data provides an overview of the distribution of the industrial water withdrawers in the state, identifies the principal groups of manufacturers using water, and provides a basis for balancing available water supplies with demand.

During the period of study an average of 11,020 million gallons per day (mgd) of water was withdrawan by industry. Surface waters supplied 10,709 mgd; groundwater sources provided 311 mgd. The largest withdrawal, 80 percent of the total, was by steam electric power plants, and the second largest withdrawal was by the primary metals industry. As the result of reuse schemes and conservation practices, water withdrawal by industry in Illinois has remained fairly stable during the past decade, despite increases in productivity.

INTRODUCTION

Industry withdraws more water from ground and surface supplies than any other segment of our society. It follows that any policies and planning related to the intelligent management of the state's water resources cannot be successfully implemented without reliable information on the quantities, sources, and distribution of water use by industry.

This report is a summary of statistics reflecting the withdrawal of fresh water from ground and surface sources by industries in Illinois during 1970-1971.

As with any array of numerical values unsupported by intimate knowledge of the many factors influencing them, there arises difficulties in presenting the data in a useful format. In the preparation of this report the need for balancing available supplies with water demand, as an essential element in water resource management, has been kept in mind. Therefore, in considering the distribution of water withdrawals by industry, use has been made of the smallest practicable geographical unit. In the case of groundwater withdrawals the counties of the state are used; for surface water withdrawals 8 hydrologic basins are used.

The term 'water withdrawal' as used here is not the same as 'water used' by an industry. In many cases the water used, through recycling, is considerably in excess of the water withdrawn. Nor is the term 'water withdrawal' to be considered synonymous with 'water consumed.' On a national average, manufacturing operations consume only 8 percent of the water withdrawn.[1] And finally the term 'water withdrawal' is the same as the term 'water intake' used by federal agencies. The reluctance to use the federal term is brought about by the fact that 'water intake' in water industry parlance denotes the in-water structure through which water is withdrawn.

All data were obtained by mail canvass and the use of a questionnaire. In developing a mailing list for the industries use was made of the Illinois Manufacturers Directory for 1970.[2] From listings in the directory all manufacturers with capitalization less than $1,000,000 were excluded from the canvass. The Illinois Commerce Commission furnished information regarding the location of power generating plants.

Questionnaires were mailed to 3728 manufacturing establishments and power generating plants. The information requested included the source of the water supply and whether or not it was self-supplied or obtained from a public utility; the daily maximum, minimum, and average water withdrawal rates; the principal use of the water such as power generation, product cooling, housekeeping, etc.; and whether or not the withdrawal rates were metered or estimated. Information was also requested concerning the pre-treatment of the water, its reuse, and whether or not it was returned to the source.

Adequate replies were received from 3029 companies. This represents an 81

percent response suggesting not only a universal interest in water but also an atmosphere of cooperation on the part of industrial management in Illinois.

The information in this report should be useful to agencies having the responsibility for water resource management in Illinois. The material has been prepared under the general supervision of Ralph L. Evans, Head of the Water Quality Section of the Illinois State Water Survey, and Dr. William C. Ackermann, Survey Chief.

DATA AND ANALYSIS

In assessing the information obtained as part of this study the principal objectives were to document the rates of water withdrawal by industry, to define the basic types of establishments exerting the greatest water withdrawal rates and their distribution in the state, and to gain a better understanding of groundwater versus surface water as current sources of supply.

Most agencies reporting on the water use of industry express water withdrawal in terms of annual rates. In this report all rates are expressed in terms of the *average* million gallons per day (mgd) of water withdrawn.

The Standard Industrial Classification Manual[3] includes a system of industrial classification and lists 422 identifiable manufacturing establishments in the United States. Each of the industries covered in this study was classified in accordance with the definitions embodied in the Standard Industrial Classification (SIC) system. The system makes it possible to tabulate and analyze data on a division, a two-digit, three-digit, or four-digit industry code basis, according to the level of industrial detail considered most appropriate. In handling the data for this report reliance was placed on the two-digit and three-digit classifications, wherein the two-digit designation applies to major industry groups and the three-digit designation denotes specific industry groups.

In using counties as geographical units 6 of them have been paired resulting in 99 entities rather than 102. The counties paired were Alexander-Pulaski, Edwards-Wabash, and Henderson-Warren.

General

During 1970-1971 the total water withdrawn by industry in Illinois, including that for power generation, was 11,020 mgd. Surface waters supplied 10,709 mgd; groundwater sources provided 311 mgd. The water required for steam electric power plants accounted for 80 percent of the total. On the basis of total water withdrawal by industry the equivalent per capita use is 1000 gallons per day (gpd). This compares favorably with the most recent report by the U. S. Geological Survey on the industrial use of water which gives the equivalent per capita use, on a national average, as 940 gpd. Excluding the water requirements of the electric power industry, the manufacturing establishments in Illinois withdraw the equivalent of 200 gpd per person residing in the state.

The trend of surface water withdrawals by industry during the past 10 years appears contrary to earlier predictions. Although differences in data collection make direct comparisons difficult, the following figures for 1950 through 1971 show that the average water withdrawal peaked at 11,743 mgd during 1959-1960.

	Average withdrawal (*mgd*)
1950-1951	7,680
1959-1960	11,743
1964-1965	10,683
1970-1971	10,709

Since 1960 industrial withdrawals have remained quite stable despite increases in productivity. The percentage of the total water withdrawn required by steam electric power plants has declined during the past 5 years from 86 percent in 1964-1965 to 80 percent in 1970-1971. Power generation requirements were 77 percent of the total in 1950-1951 and 83 percent in 1959-1960. This trend of record suggests that all segments of the industry, through reuse or other conservation measures, are using the water withdrawn more efficiently than in the past.

Cost is a prime consideration in determining whether an industry will develop its own water supply or purchase water from others. For surface water supplies, 10,005 mgd was withdrawn from self-supplied appurtenances, 473 mgd was purchased from public utilities, and 231 mgd was derived from both types of arrangements. Similarly for groundwater sources 180 mgd was self-supplied, 75 mgd was purchased,

and 56 mgd was obtained from a combination of these two arrangements. This distribution, on a percentage basis, is shown in figure 1.

Major Industry Groups

The water withdrawal data of 18 major industry groups, arranged according to the SIC system, were examined. Exclusive of steam electric power plants, 2591 manufacturing establishments were included in the grouping. As shown in table 1, the range of water withdrawals was considerable with the primary metals industries surpassing all others. The four major industries requiring the most water and their rates of withdrawal are:

Primary Metals Industries	972.8 mgd
Chemical and Allied Products	229.0
Food and Kindred Products	223.5
Machinery (except electrical)	180.8
Total	1606.1

About 50 percent of the total number of establishments are included in these four groups. They withdraw about 80 percent of the water required by all manufacturers. It has been reported by others[1] that 85 percent of water required by all manufacturing establishments in the United States during 1968 was accounted for by four major industry groups: namely, primary metals industries, chemical and allied products, paper and allied products, and petroleum and coal products. In Illinois the petroleum-coal and paper industries rank 7th and 8th, respectively, on the basis of water withdrawal among the major industry groups.

Specific Industry Groups

In examining the water withdrawal statistics for specific industries the three-digit SIC system was used for grouping. On the basis of selecting only those industries which withdraw water at a rate equal to or exceeding 0.25 percent of the total water withdrawn, 18 industrial classifications were considered, including steam electric power plants. These 18 specific industries, as shown in table 2, account for 95.6 percent of the total water withdrawal. However, they withdraw

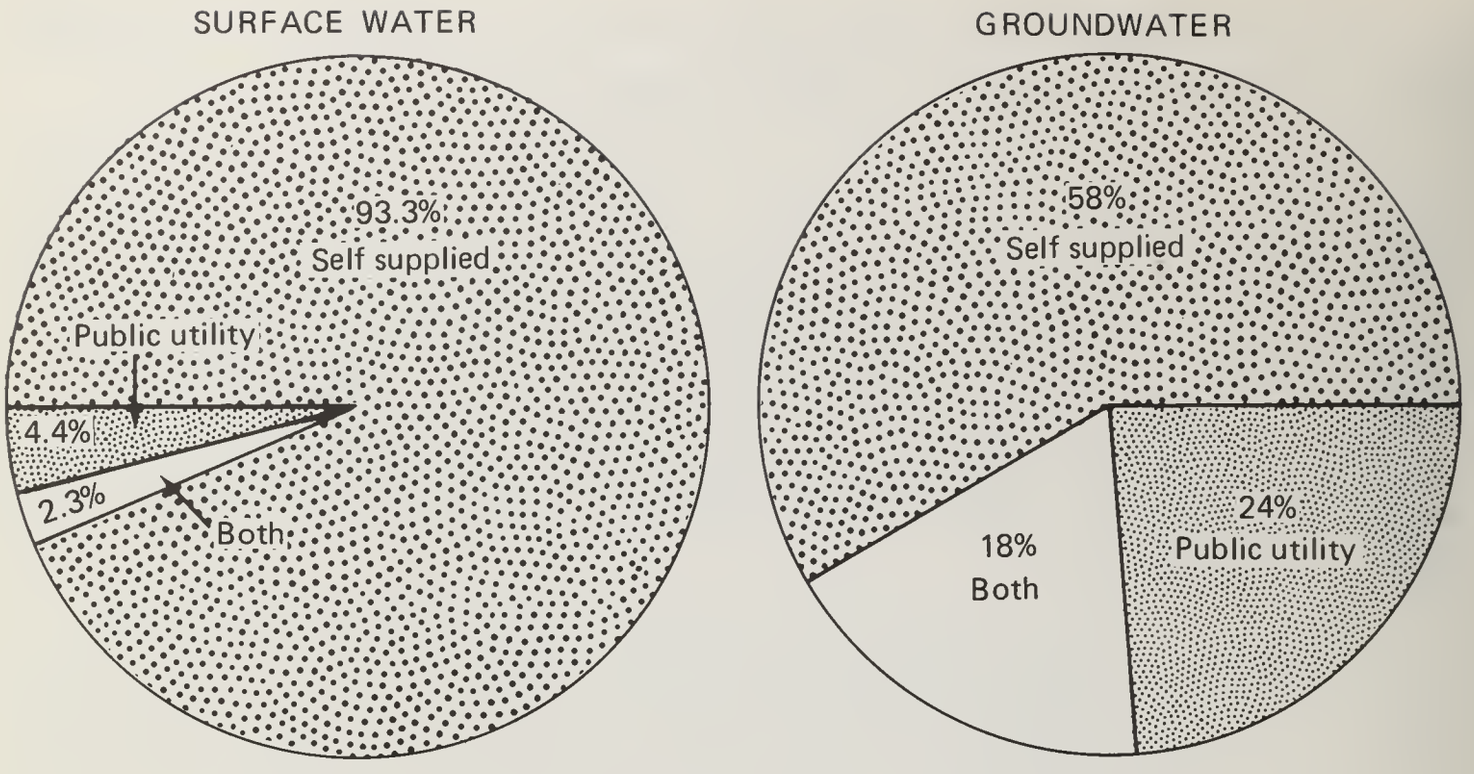

Figure 1. Type of industrial water supply development

Table 1. Total Water Withdrawal by Major Industry Groups

SIC	Groups	Number of establishments	Total withdrawal (*mgd*)	Ranking
20	Food and Kindred Products	347	223.5	3
21	Tobacco Manufacturers	1	0.3	18
22	Textile and Mill Products	21	6.5	13
24	Lumber and Wood Products	51	1.3	17
25	Furniture and Fixtures	52	6.6	12
26	Paper and Allied Products	119	32.0	8
28	Chemicals and Allied Products	269	229.0	2
29	Petroleum and Coal Products	49	89.3	7
30	Rubber and Plastic Products	84	16.9	11
31	Leather and Leather Products	6	2.3	16
32	Stone, Clay, and Glass	122	120.6	6
33	Primary Metals Industries	215	972.8	1
34	Fabricated Metal Products	363	146.4	5
35	Machinery (except Electrical)	422	180.8	4
36	Electrical Equipment and Supplies	236	27.7	9
37	Transportation Equipment	82	18.9	10
38	Instruments and Related Products	75	5.2	15
39	Misc. Manufacturing Industries	77	5.9	14
	Totals	2591	2086.0	

Table 2. Water Withdrawal by Specific Industry Groups

SIC	Groups*	Percent of total	Surface water (*mgd*)	Ground-water (*mgd*)	Total withdrawal (*mgd*)
121	Coal Mining	0.287	27.5	4.2	31.7
144	Sand and Gravel	0.332	34.4	2.2	36.6
204	Grain Mill Products	0.625	54.2	14.6	68.8
205	Bakery Products	0.462	50.0	0.9	50.9
209	Fats and Oils	0.385	21.4	21.0	42.4
275	Commercial Printing	0.431	45.9	1.6	47.5
281	Basic Chemicals	0.486	32.1	21.4	53.5
283	Drugs	0.253	19.8	8.1	27.9
289	Misc. Chemical Products	0.966	101.8	4.7	106.5
291	Petroleum Refining	0.715	64.5	14.3	78.8
321	Flat Glass	0.374	41.1	0.1	41.2
324	Cement, Hydraulic	0.434	46.7	1.1	47.8
331	Steel Rolling and Finishing	7.205	790.9	3.1	794.0
339	Primary Metals Industries	1.144	125.3	0.7	126.0
342	Cutlery, Hand Tools, Hardware	0.638	2.5	67.9	70.4
344	Fabricated Structural Metal Products	0.249	27.2	0.3	27.5
352	Farm Machinery	1.040	114.1	0.5	114.6
491	Power Generation	79.623	8774.2	0.7	8774.9
	Totals	95.649	10,373.6	167.4	10,541.0

**Those having withdrawal ≥0.25 percent of total water withdrawn*

only about 54 percent of the groundwater used. The major user of surface water is the steam electric power industry. Its water withdrawal needs represent about 82 percent of the total surface water used.

SURFACE WATER SUPPLIES

Illinois is a water excess state and surface waters are present in abundance.[5] The state, in a sense, is surrounded by fresh water with the Mississippi River on its western border, the Ohio and Wabash Rivers to the south and east, and Lake Michigan on the northeast. Within the interior the large tributaries to these major water systems are the Illinois, Kaskaskia, Rock, Sangamon, Embarras, and Kankakee Rivers. They are the principal surface water sources in the state. In

Table 3. Twenty Major Counties for Surface Water Withdrawal

County*	Surface water withdrawal (*mgd*)	Percent for power generation	Total withdrawal (*mgd*)	Number of establishments
Cook	2,460.7	53	2,497.5	1,555
Crawford	121.4	97	121.6	6
Grundy	449.2	82	550.8	9
Jackson	158.6	100	158.9	7
Lake	740.4	96	744.6	88
La Salle	121.0	0	127.1	44
Madison	799.9	87	832.2	56
Mason	210.0	100	210.2	5
Massac	568.3	100	572.1	4
Montgomery	145.1	99	145.2	9
Morgan	148.8	97	151.8	12
Peoria	441.8	91	450.8	48
Putnam	163.5	96	163.5	3
Randolph	494.0	99	494.7	11
St. Clair	121.5	81	142.8	54
Sangamon	393.3	99	394.1	24
Tazewell	423.6	94	443.8	15
Will	1,963.6	92	1,971.6	74
Williamson	108.7	97	108.7	11
Winnebago	150.1	100	231.9	108
Totals	10,283.5		10,514.2	2,143

**Includes counties furnishing at least 100 mgd for industrial purposes*

addition there are over 900 water bodies (impoundments or lakes) available for use. It is therefore not surprising that the withdrawal by industry of 10,709 mgd of surface water is not exceeding the capability of the state's valuable surface water resources.

Major Counties

Within each of 20 counties industry withdraws at least 100 million gallons of surface water per day. Located within these counties are the manufacturers and steam electric power plants accounting for 96 percent of the industrial surface water requirements in the state. These counties, in which 70 percent of the establishments responding to this investigation are located, are listed in table 3. The distribution of these counties within the state is shown in figure 2. With few

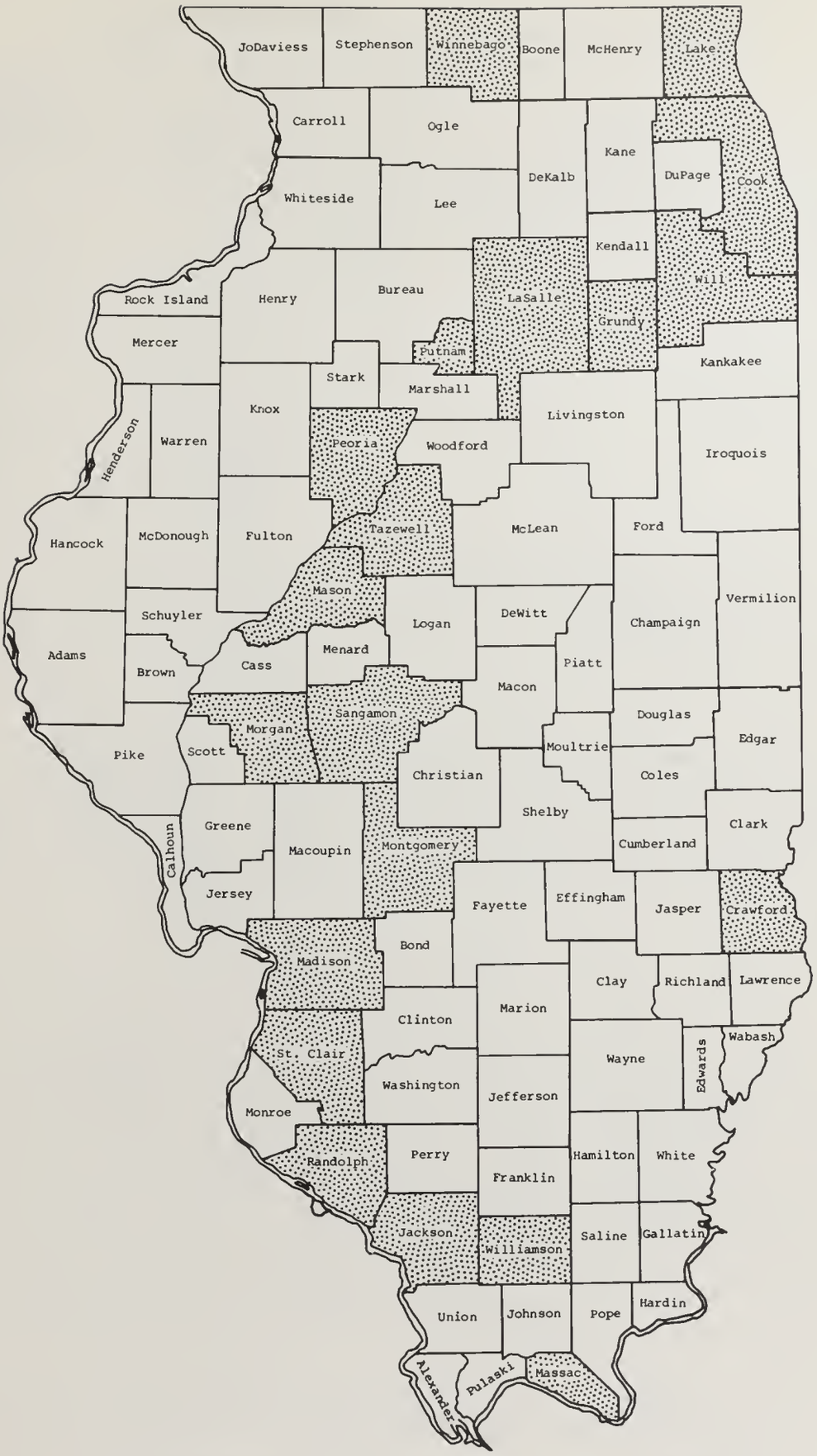

Figure 2. Major counties for surface water withdrawal

Table 4. Sources of Surface Water Withdrawal

Source	Withdrawal (*mgd*)	Percent of total withdrawal
Calumet and Little Calumet Rivers	810.5	7.6
Chicago River (North and South Branches)	29.7	0.3
Chicago Sanitary and Ship Canal	2,002.9	18.7
Des Plaines River	1,199.9	11.2
Fox River	3.0	<0.1
Illinois River	1,994.3	18.6
Kankakee River	22.8	0.2
Kaskaskia River	10.5	0.1
Lake Michigan	1,120.8	10.5
Mississippi River	1,169.5	10.9
Ohio River	568.3	5.3
Rock River	331.5	3.1
Vermilion and Little Vermilion Rivers	58.9	0.5
Wabash and Little Wabash Rivers	151.3	1.4
Miscellaneous (Private Ponds, Lakes, Springs, Impoundments)	1,235.5	11.5
Totals	10,709.4	100.0

exceptions they are located adjacent to major surface water supplies, i.e., Illinois, Mississippi, Wabash, and Ohio Rivers and Lake Michigan. Those counties appearing distant from such sources have within their boundaries sufficient tributary flows for storage impoundments.

Major Streams

The major surface water sources used by industry in Illinois are listed in table 4 and their locations depicted in figure 3. It is apparent from the listing in table 4 that private ponds, lakes, springs, and impoundments, all classified here as miscellaneous, serve as important supplies. These sources, in addition to the Chicago Sanitary and Ship Canal, the Des Plaines, Illinois, and Mississippi Rivers, and Lake Michigan, provide about 81 percent of the total surface water withdrawn by industry.

The single most important surface water system in Illinois from the standpoint of industrial withdrawals is the Illinois Waterway. In excess of one-half of the surface water used by industry is withdrawn from the system.

Figure 3. Major streams serving as sources of surface supplies for industrial withdrawals

Table 5. Surface Water Withdrawal under Average and Minimum Supply and Average Demand Conditions

Source	Mean flow (*mgd*)	Percent withdrawal of mean flow	Minimum flow (*mgd*)	Percent withdrawal of minimum flow
Chicago Sanitary and Ship Canal at Lockport	3,599	55.6	56	350.6
Des Plaines River at Illinois River confluence*	3,847	31.2	56	214.0
Fox River at Dayton	995	0.3	1	300.0
Illinois River at Meredosia	12,977	15.5	1,125	177.0
Kankakee River at Wilmington	2,491	9.1	132	17.2
Kaskaskia River at New Athens	2,341	<0.1	8	135.0
Mississippi River at Thebes	116,466	1.0	15,124	7.7
Rock River at Joslin	3,418	9.7	539	61.8

**Estimated*

A comparison between the industrial demand of surface water and varying conditions of supply are shown in table 5. In table 5 the average daily surface water withdrawal is first compared with the mean flow of the water source. In the case of the Chicago Sanitary and Ship Canal, the comparison suggests that during average stream flow conditions the average withdrawal is in excess of 50 percent of the supply. However, for more critical conditions, where stream flows are at minimums (table 5), the average withdrawal from the Chicago Sanitary and Ship Canal is more than 3 1/2 times the supply. Similarly for the Des Plaines and Fox Rivers the waters are withdrawn at a rate more than 2 times and about 3 times the minimum stream flow, respectively.

With the exception of the Des Plaines River at its confluence with the Illinois River, all flow data shown are those recorded by the U. S. Geological Survey.

Hydrologic Basins

For the purpose of regional water resource planning the state has been divided into 8 major hydrologic basins. Generally these basins are concomitant with the watershed boundaries for major river systems in Illinois. An examination was made of surface water withdrawals by industry within each basin. As shown in figure 4

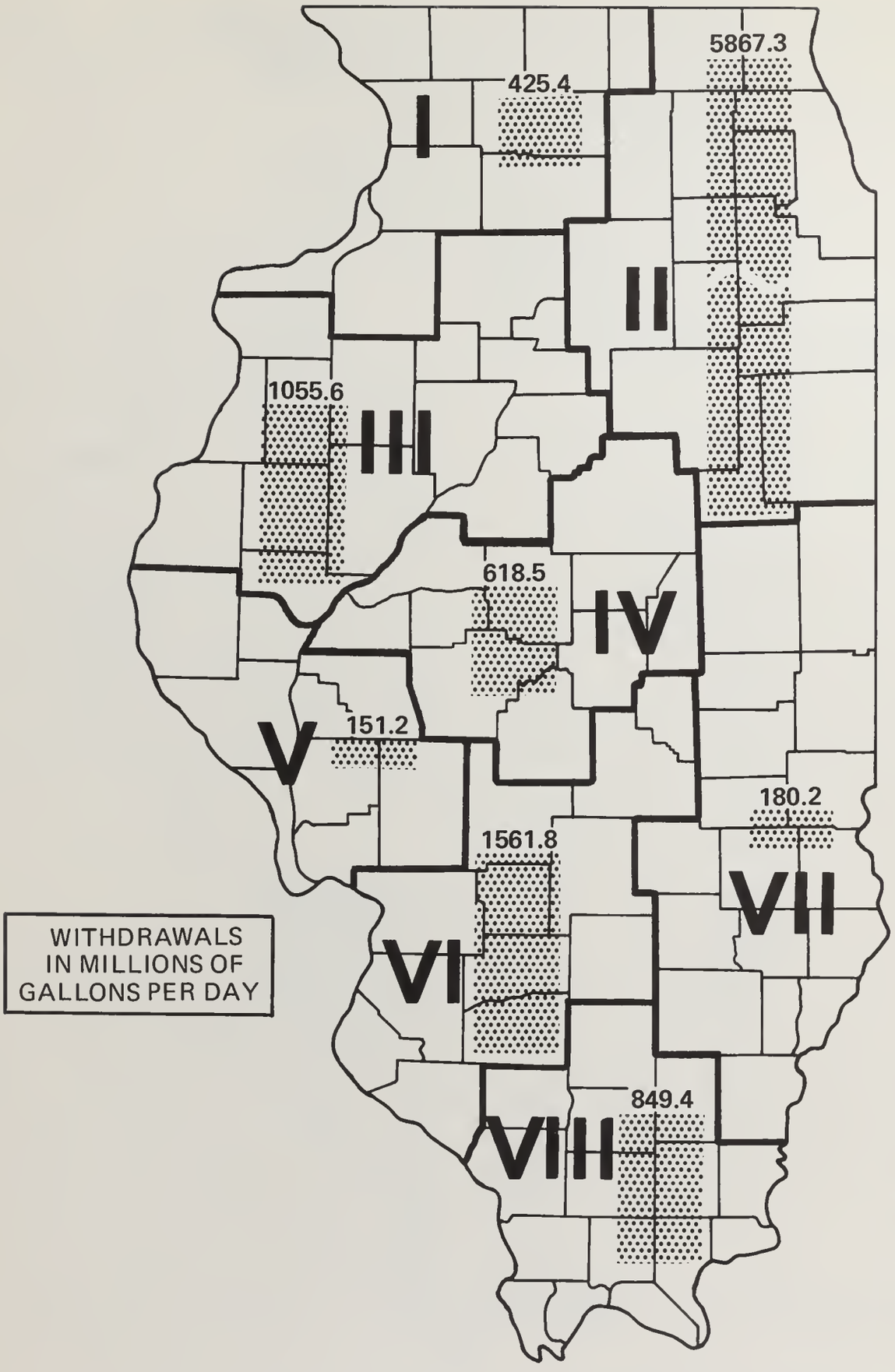

Figure 4. Surface water withdrawals in major hydrologic basins

withdrawals ranged from 151 mgd in Basin V to 5867 mgd in Basin II. Withdrawals in Basin II, the northeast sector of the state, accounted for 55 percent of the total 10,709 mgd of surface water used by industry.

GROUNDWATER SUPPLIES

Table 6. Twenty-Seven Major Counties for Groundwater Withdrawal

County*	Withdrawal (*mgd*)	Ranking
Adams	8.3	9
Boone	1.5	26
Champaign	9.0	8
Cook	37.1	2
De Kalb	1.7	22
Du Page	5.6	13
Grundy	1.6	24
Henry	1.4	25
Jo Daviess	3.7	18
Kane	15.9	6
Knox	2.7	21
Lake	4.2	16
La Salle	6.1	12
Lawrence	1.7	23
Lee	1.1	27
McHenry	6.7	11
Madison	32.3	3
Massac	3.8	17
Morgan	3.0	19
Ogle	4.5	15
Peoria	9.1	7
St. Clair	21.3	4
Stephenson	5.4	14
Tazewell	20.2	5
Whiteside	2.8	20
Will	8.0	10
Winnebago	81.8	1
Total	300.8	

**Counties having groundwater withdrawal of 1 mgd or more*

Groundwater in the state is generally derived from unconsolidated deposits of sand and gravel, principally located in glacial drift, or from limestone or sandstone formations of the underlying rock. The occurrence and distribution of these aquifers have been documented, and it has been estimated that the total groundwater potential in Illinois is 7000 mgd.[6] As noted previously, groundwater withdrawal by industry during 1970-1971 was about 311 mgd.

Major Counties

Industries in 78 counties reported the withdrawal of groundwater; however, groundwater withdrawals of 1 mgd or more were limited to 27 counties. These counties, listed and ranked in table 6, serve as sources of about 96.7 percent of the total groundwater used. Six of them (Winnebago, Cook, Madison, St. Clair, Tazewell, and Kane) are sources for about 69 percent of the groundwater withdrawn.

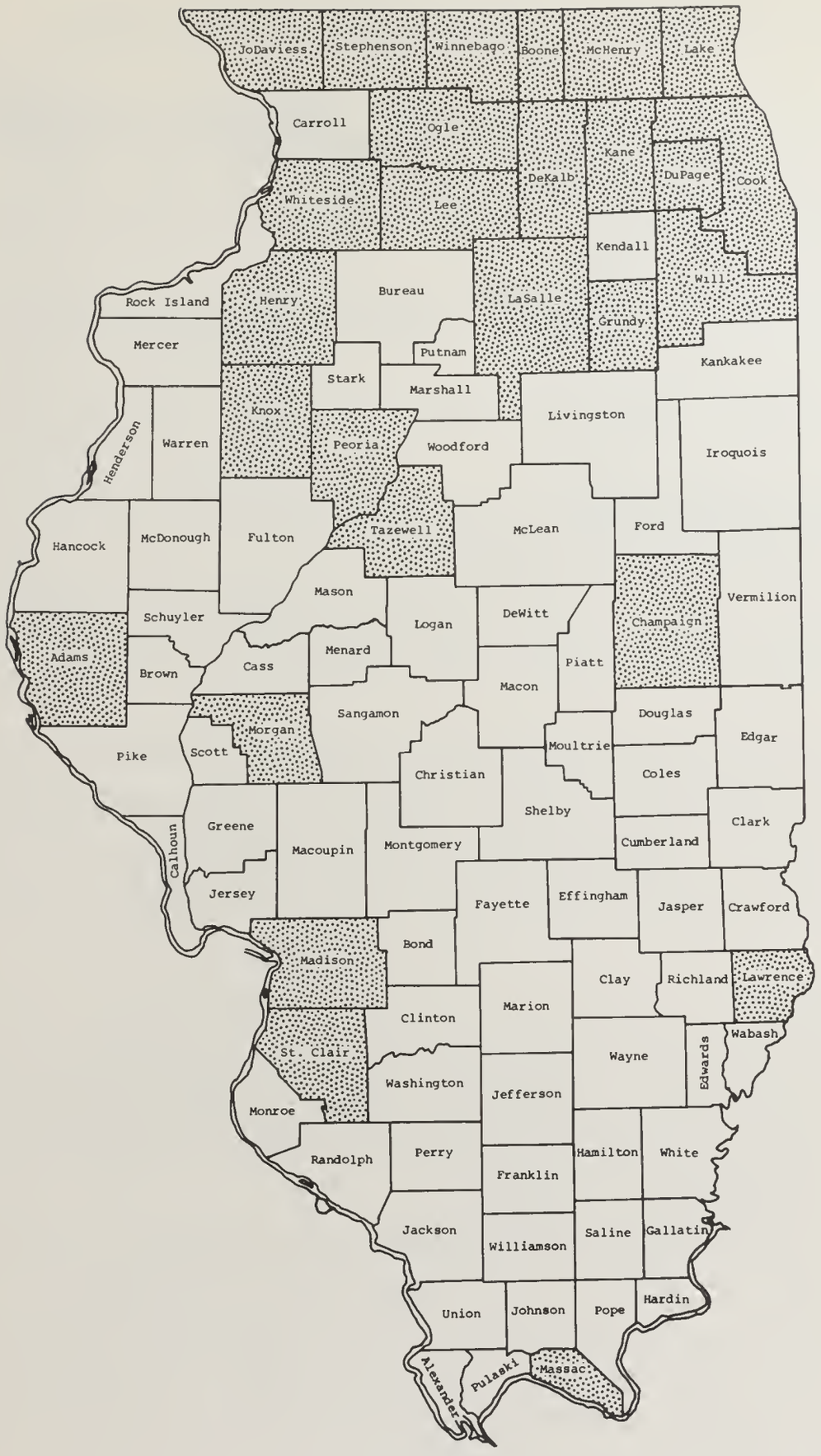

Figure 5. Major counties for groundwater withdrawal

Table 7. Groundwater Withdrawal by Major Industry Groups

SIC	Groups	Number of establishments*	Groundwater withdrawal (*mgd*)
20	Food and Kindred Products	16	49.8
22	Textile Mill Products	2	3.1
25	Furniture and Fixtures	1	5.5
26	Paper and Allied Products	4	17.7
28	Chemical and Allied Products	9	28.6
29	Petroleum and Coal Products	3	16.2
30	Rubber and Plastic Products	4	8.9
32	Stone, Clay, and Glass	1	2.8
33	Primary Metals Industries	4	10.9
34	Fabricated Metal Products	2	66.9
35	Machinery (except Electrical)	4	7.9
36	Transportation Equipment	4	12.1
37	Instruments and Related Products	2	3.6
39	Misc. Manufacturing Industries	4	9.1
	Totals	60	243.1

**Establishments (three-digit SIC) each withdrawing 1 mgd or more*

The distribution of the counties, as shown in figure 5, is basically coincident with the most favorable groundwater conditions found in the northern third and southern extremity of the state.[6] Other aquifers of high yield exist in the valleys of the Mississippi, Illinois, and Wabash Rivers and in the buried Mahomet valley.

Major Industry Groups

An examination of the data showed that each of 60 establishments (three-digit SIC) withdraws 1 mgd or more of groundwater. These industries account for 243.1 mgd or about 78 percent of the total groundwater withdrawn. They are principally located in the counties shown in figure 5.

A classification of these major groundwater users according to the two-digit SIC system is included in table 7. The 3 major users of groundwater in Illinois are industries represented by producers of: 1) fabricated metal products, 2) food and kindred products, and 3) chemicals and allied products. The specific industries within these 3 major groups utilizing groundwater sources are cutlery, hand tools, and hardware; fats and oils; and basic chemicals.

REFERENCES

1 U. S. Department of Commerce. 1971. *1967 census of manufacturers--water use in manufacturing.* Publication MC 67(1)-7, 361 p.

2 *Illinois manufacturers directory.* 1970. Manufacturers News, Inc., Chicago. 2376 p.

3 *Standard industrial classification manual.* 1972. Statistical Policy Division --Office of Management and Budget. U. S. Government Printing Office, Washington, D. C. 649 p.

4 *Water and industry.* 1971. U. S. Department of the Interior, U. S. Geological Survey Leaflet, 19 p.

5 *Atlas of Illinois resources, section 1: water resources and climate.* 1958. Illinois Division of Industrial Planning and Development, Springfield. 58 p.

6 *Water for Illinois, a plan for action.* 1967. Illinois Department of Business and Economic Development, Springfield. 452 p.

UNIVERSITY OF ILLINOIS-URBANA
3 0112 121922345